

1. A magnetically shielded magnetic tunnel junction (MTJ) cell, comprising:
 - a substrate;
 - a magnetic tunnel junction (MTJ) cell formed on the substrate, said cell having a top and sides and the horizontal cross-section of said cell having a certain geometric shape;
 - a first layer of insulation formed conformally over the sides of said cell and at least a portion of the substrate surrounding said cell;
 - a layer of magnetically shielding material formed covering the portion of said insulation on the substrate and abutting the portion of said insulation on the sides of said cell, said shielding material being thereby electrically insulated from said cell and said substrate by said insulation; and
 - a second layer of insulation formed over the magnetic shield, said layer not contacting the top of the MTJ cell; and
 - said MTJ cell having a first magnetization direction; and
 - said shielding material having a second magnetization direction; and
 - the magnetization of said MTJ cell being maintained by magnetostatic coupling to said magnetically shielding material.
2. The shielded MTJ cell of claim 1 wherein said cell is shaped by a process comprising photolithography and ion-milling in which a photolithographic stencil of the required cell shape is first formed on an unshaped cell and said stencil is then used as an ion-milling mask to produce said geometric shape.

3. The shielded MTJ cell of claim 1 wherein the shape of said cell is chosen from the group of shapes consisting of circles, ellipses, lozenge shapes, complex geometrical shapes and multi-segmented chains of such shapes.
4. The shielded MTJ cell of claim 3 wherein the shape is an ellipse.
5. The shielded MTJ cell of claim 1 wherein the insulating layer is a layer of dielectric material chosen from the group consisting of Al_2O_3 , HfO_2 , ZrO_2 and SiO_2 and said layer is formed to a thickness of between approximately 50 and 500 angstroms.
6. The shielded MTJ cell of claim 1 wherein the shielding layer is formed by a photolithographic process utilizing the same stencil used for forming said cell and whereby said shielding layer is self-aligned with said MTJ cell.
7. The shielded MTJ cell of claim 1 wherein the shielding layer is a layer of ferromagnetic material chosen from the group consisting of NiFe, CoFe, CoNiFe, CoFeB, CoZrB, CoHfB and FeN and wherein said layers have been provided with a crystalline anisotropy direction and a co-linear magnetic easy axis.
8. The shielded MTJ cell of claim 7 wherein the shielding layer is a layer of CoFe formed to a thickness between approximately 10 and 1000 angstroms.
9. The shielded MTJ cell of claim 1 wherein said cell comprises:

a ferromagnetic free layer having a first crystalline anisotropy direction;
an insulating tunneling layer formed on said free layer;
a pinned magnetic layer formed on said tunneling layer, said pinned layer further comprising:
a first ferromagnetic pinned layer having a second crystalline anisotropy direction;
a non-magnetic coupling layer formed on said first ferromagnetic pinned layer;
a second ferromagnetic pinned layer formed on said coupling layer said second ferromagnetic layer having a third crystalline anisotropy direction;
an antiferromagnetic pinning layer formed on said second ferromagnetic pinned layer and pinning its magnetization; and
the first, second and third anisotropy directions being co-linear; and
said first and second ferromagnetic pinned layers being magnetically coupled by direct coupling in antiparallel directions along said anisotropy direction; and
the total magnetic moment of said first and second ferromagnetic pinned layers being substantially zero.

10. The cell of claim 9 wherein the cell cross-sectional shape is characterized by a long axis and a short axis and the crystalline anisotropy direction is along the long axis.

11. The cell of claim 9 wherein the three ferromagnetic layers are formed of the group of ferromagnetic materials consisting of of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB,

CoZrTa, CoNbTa and CoHfTa to a thickness of between approximately 5 and 500 angstroms

12. The cell of claim 9 wherein the coupling layer is a layer of non-magnetic coupling material chosen from the group consisting of Rh, Ru, Cr and Cu and is formed to a thickness between approximately 5 and 50 angstroms.

13. The cell of claim 12 wherein the coupling layer thickness is chosen to provide exchange coupling between said first and second ferromagnetic pinned layers.

14. The cell of claim 9 wherein the antiferromagnetic pinning layer is a layer of antiferromagnetic material chosen from the group consisting of PtMn, NiMn, OsMn, IrMn, NiO and CoNiO and said layer is formed to a thickness between approximately 30 and 300 angstroms.

15. The cell of claim 9 wherein the ferromagnetic free layer is a multilayer having a non-zero magnetization comprising two ferromagnetic layers having oppositely directed magnetizations separated by a non-magnetic coupling layer that allows magnetostatic coupling between said ferromagnetic layers.

16. The shielded MTJ cell of claim 1 wherein the first magnetization direction of the MTJ cell and the second magnetization direction of the shield are substantially orthogonal.

17. The shielded MTJ cell of claim 1 wherein the shield has a coercivity between approximately 0 and 200 Oe.

18. The shielded MTJ cell of claim 1 wherein a first conducting layer is formed within said substrate beneath said MTJ cell and said layer contacts the MTJ cell.

19. The shielded MTJ cell of claim 16 further comprising a second conducting layer formed on said layer of insulation, said conducting layer contacting the top of said MTJ cell.

20. An array of shielded MTJ cells comprising:

a substrate;

a plurality of MTJ cells disposed in a uniform array on said substrate, each MTJ cell having a top and sides and a horizontal cross-section of a given geometrical shape;

an insulating layer formed on the substrate and also covering the sides of said MTJ cells;

a patterned magnetic shield formed over the insulating layer on the substrate, said shield conformally abutting and contacting at least a portion of the insulating layer on the side of each MTJ cell;

a second layer of insulation formed over the magnetic shield, said layer not contacting the top of the MTJ cell; and

said magnetic shield is electrically insulated from said substrate and from each MTJ cell; and

each MTJ cell is magnetized in a first direction; and

said magnetic shield is magnetized in a second direction; and

each MTJ cell is magnetostatically coupled to said magnetic shield.

21. The array of shielded MTJ cells of claim 20 wherein each said cell is shaped by a process comprising photolithography and ion-milling in which a photolithographic stencil of the required cell shape is first formed on an unshaped cell and said stencil is then used as an ion-milling mask to produce said geometric shape.

22. The array of shielded MTJ cells of claim 21 wherein the magnetic shield is formed and patterned using said photolithographic stencil, whereby said shield is self-aligned with said MTJ cells.

23. The array of shielded MTJ cells of claim 22 wherein a crystalline anisotropy direction of the shield is determined during its formation by placing said shield in an external magnetic field between approximately 30 and 60 Oe in said direction and whereby there is produced an easy axis in a direction of preferred magnetization.

24. The array of shielded MTJ cells of claim 23 wherein the direction of magnetization of the shield and the direction of magnetization of the MTJ cell are substantially orthogonal.
25. The array of shielded MTJ cells of claim 24 wherein the shielding layer is a layer of ferromagnetic material chosen from the group consisting of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said layer is formed to a thickness between approximately 10 and 1000 angstroms.
26. The array of shielded MTJ cell of claim 25 wherein the shielding layer is a layer of CoFe.
27. The array of shielded MTJ cells of claim 24 wherein the horizontal cross-sectional shape is chosen from the group of shapes including ellipses, rectangles, lozenges, notched geometric shapes, shapes having their narrowest dimension at their middles, segmented shapes, chains of circles and other regular and irregular geometric shapes.
28. The array of shielded MTJ cells of claim 27 wherein the horizontal cross-sectional shape of each cell has a long axis and a short axis, wherein said axes are mutually orthogonal and wherein said cells form rows of uniformly separated cells in which their major axes are co-linear and columns of uniformly separated cells in which their minor axes are co-linear and define, thereby, an orthogonal rectangular array whose first and second array axes extend co-linearly along said short and long axes respectively.

29. The array of shielded MTJ cells of claim 28 wherein the horizontal cross-sectional shape is an ellipse.

30. The array of shielded MTJ cells of claim 26 wherein the coercivity of the shield is between approximately 0 and 200 Oe.

31. The array of shielded MTJ cells of claim 28 wherein said shield is patterned to form continuous, substantially rectangular strips whose long edge is parallel to said first array axis, said strips being separated along the direction of said second array axis by substantially rectangular gaps also parallel to said first array axis, the mid-lines of said gaps passing through the centers of the MTJ cells aligned in columns along said first array axis and said gaps being narrower than the major axis of the cells so that horizontally disposed end portions of said cells extend into, are conformally surrounded by, but are electrically insulated from, separated portions of said shield disposed across the gap from each other.

32. The array of shielded MTJ cells of claim 31 further comprising parallel, uniformly separated gaps extending along the direction of the second array axis, the mid-line of said gaps passing midway between said MTJ cells.

33. The array of shielded MTJ cells of claim 32 further comprising parallel, uniformly separated gaps extending along the direction of the first array axis and passing between opposite edges of adjacent MTJ cells.

34. The array of shielded MTJ cells of claim 16 further comprising a second conducting layer formed on said layer of insulation, said conducting layer contacting the top of said MTJ cell.

35. The array of shielded MTJ cells of claim 20 wherein each said MTJ cell comprises:

- a ferromagnetic free layer having a first crystalline anisotropy direction;

- a insulating tunneling layer formed on said free layer;

- a pinned magnetic layer formed on said tunneling layer, said pinned layer further comprising:

- a first ferromagnetic pinned layer having a second crystalline anisotropy direction;

- a non-magnetic coupling layer formed on said first ferromagnetic pinned layer;

- a second ferromagnetic pinned layer formed on said coupling layer said second ferromagnetic layer having a third crystalline anisotropy direction;

- an antiferromagnetic pinning layer formed on said second ferromagnetic pinned layer and pinning its magnetization; and

the first, second and third anisotropy directions being co-linear; and
said first and second ferromagnetic pinned layers being magnetically
coupled by direct coupling in antiparallel directions along said anisotropy direction; and
the total magnetic moment of said first and second ferromagnetic pinned layers
being substantially zero.

36. An array of MTJ cells shielded by a stabilized magnetic shield comprising:
- a substrate;
 - a plurality of MTJ cells disposed in a uniform array on said substrate, each MTJ cell having a top and sides and a horizontal cross-section of a given geometrical shape;
 - an insulating layer formed on the substrate and also covering the sides of said MTJ cells;
 - a patterned stabilized magnetic shield formed over the insulating layer on the substrate, said shield having a first patterned portion and a second patterned portion, wherein said first patterned portion conformally abuts and contacts at least a portion of the insulating layer on the side of each MTJ cell;
 - a second layer of insulation formed over the magnetic shield, said layer not contacting the tops of said MTJ cells; and
 - both portions of said magnetic shield are electrically insulated from said substrate and from each MTJ cell; and
 - each MTJ cell is magnetized in a first direction; and
 - the first portion of said magnetic shield is magnetized in a second direction substantially orthogonal to the first direction; and

each MTJ cell is magnetostatically coupled to said first portion of the magnetic shield; and

the second portion of said magnetic shield stabilizes the magnetization of said first portion by a form of magnetic coupling.

37. The array of MTJ cells of claim 36 wherein each said cell is shaped by a process comprising photolithography and ion-milling in which a photolithographic stencil of the required cell shape is first formed and said stencil is then used as an ion-milling mask to produce said geometric shape.

38. The array of MTJ cells of claim 37 wherein both said portions of said magnetic shield are formed and patterned using a self-aligned process of photolithography and ion-milling wherein the photolithographic stencil for said shield is aligned with the photolithographic stencil for the MTJ cells.

39. The array of MTJ cells of claim 38 wherein the horizontal cross-sectional shape of each cell has a long axis and a short axis, wherein said axes are mutually orthogonal and wherein said cells form rows of uniformly separated cells in which their major axes are co-linear and columns of uniformly separated cells in which their minor axes are co-linear and define, thereby, an orthogonal rectangular array whose first and second array axes extend co-linearly along said short and long axes respectively.

40. The array of MTJ cells of claim 39 wherein said first portion is patterned to form continuous, substantially rectangular strips of equal length and width, whose upper and lower edges are co-linear along said second array axis and whose long edge is parallel to said first array axis, said strips being separated along the direction of said second array axis by substantially rectangular gaps also parallel to said first array axis, the mid-lines of said gaps passing through the centers of the MTJ cells aligned in columns along said first array axis and said gaps being narrower than the major axis of the cells so that horizontally disposed end portions of said cells extend into, are conformally surrounded by, but are electrically insulated from, separated portions of said shield disposed across the gap from each other and wherein said second portion of the shield is formed as two horizontal rectangular strips extending in the second array axis direction and contacting the upper and lower edges of said first portion of the shields.

41. The array of MTJ cells of claim 40 wherein said first portion of the shield is further patterned by the formation of parallel, uniformly spaced gaps extending in the direction of said second array axis, the mid-line of said gaps passing midway between the centers of the MTJ cells aligned in rows along said first array axis and wherein said second portion of the shield further comprises rectangular strips of magnetic material formed within said gaps formed in the second array axis direction.

42. The array of MTJ cells of claim 41 wherein said first portion of the shield is further patterned by the formation of a second set of parallel, uniformly spaced gaps extending in the direction of said first array axis, the mid-line of said second set of gaps

passing midway between the centers of the MTJ cells aligned in columns along said first array axis and wherein said second portion of the shield further comprises rectangular strips of magnetic material formed within said second set of gaps formed in the first array axis direction.

43. The array of MTJ cells of claim 40 wherein said first portion of the shield is patterned to form rectangular segments, the long sides of said segments being parallel to the first array axis and the short sides being parallel to the second array axis, the segments being formed by and their sides being bounded by continuous gaps extending in the direction of said first and second array axis, and wherein each rectangular segment contains at least one MTJ cell and wherein said second portion of the shield comprises strips of magnetic material formed in said gaps.

44. The array of MTJ cells of claim 40 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of permanent magnetic material chosen from the group consisting of Co, CoCr, CoCrPt, CoPt, CoCrB, CoPtB, CoP or CoNiFe, said second portion stabilizing the magnetization of said first portion by magnetostatic coupling.

45. The array of MTJ cells of claim 41 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of of CoFe, NiFe, CoNiFe,

CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of permanent magnetic material chosen from the group consisting of Co, CoCr, CoCrPt, CoPt, CoCrB, CoPtB, CoP or CoNiFe, said second portion stabilizing the magnetization of said first portion by magnetostatic coupling.

46. The array of MTJ cells of claim 42 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of CoFe, CoFeNi----- and said patterned second portion is formed of permanent magnetic material chosen from the group consisting of Co, CoCr, CoCrPt, CoPt, CoCrB, CoPtB, CoP or CoNiFe, said second portion stabilizing the magnetization of said first portion by magnetostatic coupling.

47. The array of MTJ cells of claim 43 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of CoFe, CoFeNi----- and said patterned second portion is formed of permanent magnetic material chosen from the group consisting of Co, CoCr, CoCrPt, CoPt, CoCrB, CoPtB, CoP or CoNiFe, said second portion stabilizing the magnetization of said first portion by magnetostatic coupling.

48. The array of MTJ cells of claim 40 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of antiferromagnetic material chosen from the group of such material consisting

of PtMn, NiMn, IrMn, OsMn, PdPtMn, NiO, CoO or CoNiO, said second portion stabilizing the magnetization of said first portion by exchange coupling.

49. The array of MTJ cells of claim 41 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of antiferromagnetic material chosen from the group of such material consisting of PtMn, NiMn, IrMn, OsMn, PdPtMn, NiO, CoO or CoNiO, said second portion stabilizing the magnetization of said first portion by exchange coupling.

50. The array of MTJ cells of claim 42 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of antiferromagnetic material chosen from the group of such material consisting of PtMn, NiMn, IrMn, OsMn, PdPtMn, NiO, CoO or CoNiO, said second portion stabilizing the magnetization of said first portion by exchange coupling.

51. The array of MTJ cells of claim 43 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of antiferromagnetic material chosen from the group of such material consisting of PtMn, NiMn, IrMn, OsMn, PdPtMn, NiO, CoO or CoNiO, said second portion stabilizing the magnetization of said first portion by exchange coupling.

52. The array of MTJ cells of claim 36 wherein each said MTJ cell comprises:
- a ferromagnetic free layer having a first crystalline anisotropy direction;
 - an insulating tunneling layer formed on said free layer;
 - a pinned magnetic layer formed on said tunneling layer, said pinned layer further comprising:
 - a first ferromagnetic pinned layer having a second crystalline anisotropy direction;
 - a non-magnetic coupling layer formed on said first ferromagnetic pinned layer;
 - a second ferromagnetic pinned layer formed on said coupling layer said second ferromagnetic layer having a third crystalline anisotropy direction;
 - an antiferromagnetic pinning layer formed on said second ferromagnetic pinned layer and pinning its magnetization; and
 - the first, second and third anisotropy directions being co-linear; and
 - said first and second ferromagnetic pinned layers being magnetically coupled by direct coupling in antiparallel directions along said anisotropy direction; and
 - the total magnetic moment of said first and second ferromagnetic pinned layers being substantially zero.

53. A method of forming a magnetically shielded magnetic tunnel junction (MTJ) cell, comprising:

providing a substrate;

forming a magnetic tunnel junction (MTJ) cell on the substrate, said cell having a top and sides and the horizontal cross-section of said cell having a certain geometric shape;

forming a layer of insulation conformally over the sides of said cell and at least a portion of the substrate surrounding said cell;

forming a layer of magnetically shielding material covering the portion of said insulation on the substrate and abutting the portion of said insulation on the sides of said cell, said shielding material being thereby electrically insulated from said cell and said substrate by said insulation;

forming a second layer of insulation over said magnetically shielding material, said second layer not contacting the top of said MTJ cell; and

magnetizing said cell along a first direction; and

magnetizing said shielding material along a second direction; and

maintaining the magnetization of said cell by magnetostatic coupling to said magnetically shielding material.

54. The method of claim 53 wherein said cell is shaped by a process comprising photolithography and ion-milling in which a photolithographic stencil of the required cell shape is first formed and said stencil is then used as an ion-milling mask to produce the geometric shape.

55. The method of claim 54 wherein said geometric shape of said cell is chosen from the group of shapes consisting of circles, ellipses, lozenge shapes, complex geometrical shapes and multi-segmented chains of such shapes.

56. The method of claim 54 wherein the shielding layer is formed by a self aligned photolithographic process, wherein the photolithographic stencil used in the shaping of said cell is also used in the formation and patterning of said shield.

57. The method of claim 53 wherein the formation of said MTJ cell comprises:
forming a ferromagnetic free layer having a first crystalline anisotropy direction;
forming an insulating tunneling layer on said free layer;
forming a pinned magnetic layer on said tunneling layer, said pinned layer
formation further comprising:

forming a first ferromagnetic pinned layer having a second crystalline
anisotropy direction;

forming a non-magnetic coupling layer on said first ferromagnetic pinned
layer;

forming a second ferromagnetic pinned layer on said coupling layer said
second ferromagnetic layer having a third crystalline anisotropy direction;

forming an antiferromagnetic pinning layer on said second ferromagnetic
pinned layer and, thereby, pinning its magnetization; and

the first, second and third anisotropy directions being co-linear; and
said first and second ferromagnetic pinned layers being magnetically

coupled by direct coupling in antiparallel directions along said anisotropy direction; and
the total magnetic moment of said first and second ferromagnetic pinned layers
being substantially zero.

58. The method of claim 57 wherein the cell cross-sectional shape is characterized by
a long axis and a short axis and the crystalline anisotropy direction is along the long axis.

59. The method of claim 57 wherein the non-magnetic coupling layer thickness is
chosen to provide direct magnetostatic coupling between said first and second
ferromagnetic pinned layers.

60. The method of claim 53 wherein the first magnetization direction of the MTJ cell
and the second magnetization direction of the shield are substantially orthogonal.

61. The method of claim 60 wherein the coercivity of the shield is between
approximately 0 and 200 Oe.

62. A method for forming an array of shielded MTJ cells comprising:
providing a substrate;
disposing a plurality of MTJ cells in a uniform array on said substrate, each MTJ
cell having a top and sides and a horizontal cross-section of a given geometrical shape;
forming an insulating layer on the substrate and the sides of said MTJ cells;

forming a patterned magnetic shield over the insulating layer on the substrate, said shield conformally abutting and contacting at least a portion of the insulating layer on the side of each MTJ cell;

forming a layer of insulation over the magnetic shield, said layer not contacting the top of said MTJ cells;

wherein said magnetic shield is electrically insulated from said substrate and from each MTJ cell; and

wherein each MTJ cell is magnetized in a first direction; and

wherein said magnetic shield is magnetized in a second direction; and

wherein each MTJ cell is magnetostatically coupled to said magnetic shield.

63. The method of claim 62 wherein said cell is shaped by a process comprising photolithography and ion-milling in which a photolithographic stencil of the required cell shape is first formed and said stencil is then used as an ion-milling mask to produce said geometric shape.

64. The method of claim 63 wherein the magnetic shield is formed and patterned using a self-aligned process of photolithography and ion-milling wherein the photolithographic stencil for the shield is aligned with the photolithographic stencil for the MTJ cells.

65. The method of claim 64 wherein a crystalline anisotropy of the shield is determined during its formation and aligned to form an easy axis of magnetization in a

direction of preferred magnetization by forming said shield in an external magnetic field of between approximately 30 and 60 Oe and directed along said direction of preferred magnetization.

66. The method of claim 62 wherein the direction of magnetization of the shield and the direction of magnetization of the MTJ cell are substantially orthogonal.

67. The method of claim 63 wherein the horizontal cross-sectional shape is chosen from the group of shapes including ellipses, rectangles, lozenges, notched geometric shapes, geometric shapes whose minimum dimension is in their middle, segmented shapes, chains of circles and other regular and irregular geometric shapes.

68. The method of claim 67 wherein the horizontal cross-sectional shape of each cell has a long axis and a short axis, wherein said axes are mutually orthogonal and wherein said cells form rows of uniformly separated cells in which their major axes are co-linear and columns of uniformly separated cells in which their minor axes are co-linear and define, thereby, an orthogonal rectangular array whose first and second array axes extend co-linearly along said short and long axes respectively.

69. The method of claim 68 wherein said shield is patterned to form continuous, substantially rectangular strips of equal length and width, whose shorter edges are aligned co-linearly with said second array axis and whose long edge is parallel to said first array

axis, said strips being separated along the direction of said second array axis by substantially rectangular gaps also parallel to said first array axis, the mid-lines of said gaps passing through the centers of the MTJ cells aligned in columns along said first array axis and said gaps being narrower than the major axis of the cells so that horizontally disposed end portions of said cells extend into, are conformally surrounded by, but are electrically insulated from, separated portions of said shield disposed across the gap from each other.

70. The method of claim 69 wherein said shield is patterned to further comprise parallel, uniformly separated gaps extending along the direction of the second array axis, the mid-line of said gaps passing midway between said MTJ cells.

71. The method of claim 69 wherein said shield is patterned to further comprise parallel, uniformly separated gaps extending along the direction of the first array axis and passing between opposite edges of adjacent MTJ cells.

72. A method of forming an array of MTJ cells shielded by stabilized magnetic shields comprising:

providing a substrate;

forming on said substrate a plurality of MTJ cells disposed in a uniform array on said substrate, each MTJ cell having a top and sides and a horizontal cross-section of a given geometrical shape;

forming an insulating layer on said substrate, said insulating layer also covering the sides of said MTJ cells;

forming a patterned stabilized magnetic shield over the portion of said insulating layer on the substrate, said shield having a first patterned portion and a second patterned portion, wherein said first patterned portion conformally abuts and contacts at least a portion of the insulating layer on the side of each MTJ cell;

forming a second layer of insulation over said patterned stabilized magnetic shield, said second layer not contacting the tops of said MTJ cells; and wherein

both portions of said magnetic shield are electrically insulated from said substrate and from each MTJ cell; and wherein

each MTJ cell is magnetized in a first direction; and wherein

said first portion of the magnetic shield is magnetized in a second direction substantially orthogonal to the first direction; and wherein

each MTJ cell is magnetostatically coupled to said first portion of the magnetic shield; and wherein

said second portion of the magnetic shield stabilizes the magnetization of the first portion by a form of magnetic coupling.

73. The method of claim 72 wherein each said MTJ cell is shaped by a process comprising photolithography and ion-milling in which a photolithographic stencil of the required cell shape is first formed and said stencil is then used as an ion-milling mask to produce said geometric shape.

74. The method of claim 73 wherein both said portions of the magnetic shield are formed and patterned using a self-aligned process of photolithography wherein the photolithographic stencil used for forming the shield is the same photolithographic stencil used for shaping the MTJ cells.

75. The method of claim 73 wherein the horizontal cross-sectional shape of each cell has a long axis and a short axis, wherein said axes are mutually orthogonal and wherein said cells form rows of uniformly separated cells in which their major axes are co-linear and columns of uniformly separated cells in which their minor axes are co-linear and define, thereby, an orthogonal rectangular array whose first and second array axes extend co-linearly along said short and long axes respectively.

76. The method of claim 75 wherein said first portion is patterned to form continuous, substantially rectangular strips of equal length and width, whose upper and lower edges are co-linear along said second array axis and whose long edge is parallel to said first array axis, said strips being separated along the direction of said second array axis by substantially rectangular gaps also parallel to said first array axis, the mid-lines of said gaps passing through the centers of the MTJ cells aligned in columns along said first array axis and said gaps being narrower than the major axis of the cells so that horizontally disposed end portions of said cells extend into, are conformally surrounded by, but are electrically insulated from, separated portions of said shield disposed across the gap from each other and wherein said second portion of the shield is formed as two

horizontal rectangular strips extending in the second array axis direction and contacting the upper and lower edges of said first portion of the shields.

77. The method of claim 76 wherein said first portion of the shield is further patterned by the formation of parallel, uniformly spaced gaps extending in the direction of said second array axis, the mid-line of said gaps passing midway between the centers of the MTJ cells aligned in rows along said first array axis and wherein said second portion of the shield further comprises rectangular strips of magnetic material formed within said gaps formed in the second array axis direction.

78. The method of claim 77 wherein said first portion of the shield is further patterned by the formation of a second set of parallel, uniformly spaced gaps extending in the direction of said first array axis, the mid-line of said second set of gaps passing midway between the centers of the MTJ cells aligned in columns along said first array axis and wherein said second portion of the shield further comprises rectangular strips of magnetic material formed within said second set of gaps formed in the first array axis direction.

79. The method of claim 75 wherein said first portion of the shield is patterned to form rectangular segments, the long sides of said segments being parallel to the first array axis and the short sides being parallel to the second array axis, the segments being formed

by and their sides being bounded by continuous gaps extending in the direction of said first and second array axis, and wherein each rectangular segment contains at least one MTJ cell and wherein said second portion of the shield comprises strips of magnetic material formed in said gaps.

80. The method of claim 75 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of permanent magnetic material chosen from the group consisting of Co, CoCr, CoCrPt, CoPt, CoCrB, CoPtB, CoP or CoNiFe, said second portion stabilizing the magnetization of said first portion by magnetostatic coupling.

81. The method of claim 76 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of permanent magnetic material chosen from the group consisting of Co, CoCr, CoCrPt, CoPt, CoCrB, CoPtB, CoP or CoNiFe, said second portion stabilizing the magnetization of said first portion by magnetostatic coupling.

82. The method of claim 77 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of permanent magnetic material chosen from the group consisting of Co, CoCr,

CoCrPt, CoPt, CoCrB, CoPtB, CoP or CoNiFe, said second portion stabilizing the magnetization of said first portion by magnetostatic coupling.

83. The method of claim 78 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of permanent magnetic material chosen from the group consisting of Co, CoCr, CoCrPt, CoPt, CoCrB, CoPtB, CoP or CoNiFe, said second portion stabilizing the magnetization of said first portion by magnetostatic coupling.

84. The method of claim 75 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of antiferromagnetic material chosen from the group of such material consisting of PtMn, NiMn, IrMn, OsMn, PdPtMn, NiO, CoO or CoNiO, said second portion stabilizing the magnetization of said first portion by exchange coupling.

85. The method of claim 76 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of antiferromagnetic material chosen from the group of such material consisting of PtMn, NiMn, IrMn, OsMn, PdPtMn, NiO, CoO or CoNiO, said second portion stabilizing the magnetization of said first portion by exchange coupling.

86. The method of claim 77 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of antiferromagnetic material chosen from the group of such material consisting of PtMn, NiMn, IrMn, OsMn, PdPtMn, NiO, CoO or CoNiO, said second portion stabilizing the magnetization of said first portion by exchange coupling.

87. The method of claim 78 wherein said patterned first portion is formed of ferromagnetic material chosen from the group consisting of of CoFe, NiFe, CoNiFe, CoZrTa, CoFeB, CoZrTa, CoNbTa and CoHfTa and said patterned second portion is formed of antiferromagnetic material chosen from the group of such material consisting of PtMn, NiMn, IrMn, OsMn, PdPtMn, NiO, CoO or CoNiO, said second portion stabilizing the magnetization of said first portion by exchange coupling.